

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

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METAL CONSTRUCTION OF AIRCRAFT.

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In the prehistoric days of aviation, when the duration record stood in the neighborhood of an hour, and when pilots never went forth to fly except in the most gentle of zephyrs - in short, about 1909 - it used to be said with confidence that the airplanes of the future would be built in the carpenter shops of the future. It was not unnatural that the pioneers should have held that view, or that they should have acted in accordance with what they prophesied for times to come. When a mechanic is building a single airplane to his own designs in a backyard workshop it is certainly far easier to work in wood than in any other material, particularly when it is almost certain that the airplane will be destroyed by accident or have to be scrapped as antiquated in design long before the most perishable of structural materials could wear out.

Times have changed in 13 years, however, and no one who has watched the progress of aircraft construction during and since the war would dare to deny that the future belongs largely, if not solely, to metal construction. That being so, it is of interest to examine into the present status of metals for aeronautical work and to see how far we have already advanced along the road to their complete utilization and the exclusion of wood.

Although metal construction is hardly beginning as yet, its practicability has been demonstrated beyond question. It has

* Taken from Christian Science Monitor, August 28, 1922.

repeatedly been shown that an airplane can be built out of metal quite as lightly for the same strength as it can out of wood, and the uniformity of strength between two similar metallic structures is much greater than between two of wood, the timber itself being sadly lacking in uniformity, even with the most careful selection. The only thing that keeps metal from more extended use is the preliminary expense, which imposes an intolerable overhead. The making of metal spars, for example, requires a preliminary equipment of dies and rolls and special tools which is far beyond that necessary for wooden construction, and metal airplanes cannot be built cheaply, and therefore will not be built commonly until the public interest in aeronautics is aroused to such a point that the demand justifies the production of airplanes in considerable quantities. When that time comes we may expect to see wood largely disappear, as it has already done in special experimental airplanes. At least one airplane has already been built in which literally the only non-metallic part was the upholstery of the pilot's seat, even the propeller being of metal and the usual rubber cord shock absorbers being replaced by steel springs.

The subject of metal construction is not one which can be treated as a unit. There are several conflicting views as to particular metals and types of construction held even by those who favor most heartily the suppression of timber, and the practices which have grown up and been accepted as successful differ widely in different nations.

The most fundamental line of cleavage is between those who believe in the supremacy of steel and those who favor rather the so-called "light alloys," containing large proportions of aluminium or magnesium. Steel construction has undoubtedly progressed farthest in Great Britain, aluminium alloys being looked on with grave distrust there as uncertain in their properties and liable to sudden failure without previous warning, especially after prolonged exposure to the weather. In Germany and in the United States, on the other hand, light alloys, and particularly that one technically known as duralumin, have been freely employed and comparatively little trouble has been experienced. French constructors have made some use of both metals, but military considerations have led to the concealment of most of the facts regarding the work done, and it is therefore difficult to compare French practice with that of the other nations.

The great advantage of steel is the long experience of the companies making it, which insures a product constant in its strength and other characteristics. It also has the merit of being weldable, at least so long as abnormally high strength is not sought for, and joints can be quickly, cheaply, and neatly made by that method where riveting would have to be employed in connection with aluminium. The aluminium alloys, on the other hand, are soft and easy to work and their lightness makes it possible to employ much thicker sections than could be used in corresponding members made of steel. This is an important advantage. It is sometimes found, for example, when required

strengths are calculated by the ordinary methods, that a steel tube two inches in diameter and with a wall a hundredth of an inch thick would be required for a particular part. Simple theories break down in dealing with members of such proportions, however, for the merest touch against a tube so thin suffices to distort the wall, and early failure will then ensue at the point of irregularity of form. Under the same conditions a duralumin tube of the same diameter could have a wall nearly three times as thick and correspondingly more rigid without any increase in weight.

Where steel is used it is usually necessary to employ sections of very peculiar appearance stiffened by corrugation or otherwise, and most of the failures or partial failures of attempts to use metal construction in the past can be attributed to too close an imitation of the assemblies used in wood. The change from wood to metal requires initiative on the part of the designer as well as the metallurgist, for the whole arrangement of the structure must be cast along new lines for best results.

While steel and the light alloys both have their advocates for such structural parts as wing spars and the principal longitudinals of the body, there is only one possibility if metal is to replace fabric as a wing covering. Sheets of steel for that purpose would either be prohibitively heavy or so thin that the touch of a finger would dent and injure them, and aluminium alloys hold the field alone. Here, too, it has been found wise to use a corrugated section for greater stiffness in preference to laying the sheets flat.

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